United States
Department of
Agriculture
Forest Service
State and Private
Forestry
Northeastern Area

NA-PR-02-02
January 2002

Sudden Oak Death

Oak mortality is caused by a new pathogen, *Phytophthora ramorum*

A phenomenon known as Sudden Oak Death was first reported in 1995 in central coastal California. Since then, tens of thousands of tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*), and California black oaks (*Quercus kelloggii*) have been killed by a newly identified fungus, *Phytophthora ramorum*. On these hosts, the fungus causes a bleeding canker on the stem. The pathogen also infects *Rhododendron* spp., huckleberry (*Vaccinium ovatum*), bay laurel (*Umbellularia californica*), madrone (*Arbutus menziesii*), bigleaf maple (*Acer macrophyllum*), manzanita (*Arctostaphylos manzanita*), and California buckeye (*Aesculus californica*). On these hosts the fungus causes leaf spot and twig dieback.

In California *Phytophthora ramorumcauses* **crown symptoms and tree mortality.**

As of January 2002, the disease was known to occur only in California and southwestern Oregon; however, transporting infected hosts may spread the disease. The pathogen has the potential to infect oaks and other trees and shrubs elsewhere in the United States. Limited tests show that many oaks are susceptible to the fungus, including northern red oak and pin oak, which are highly susceptible.

On oaks and tanoak, cankers are formed on the stems. Cankered trees may survive for one to several years, but once crown dieback begins, leaves turn from green to pale yellow to brown within a few weeks. A black or reddish ooze often bleeds from the cankers, staining the surface of the bark and the lichens that grow on it. Bleeding ooze may be difficult to see if it has dried or has been washed off by rain, although remnant dark staining is usually present.

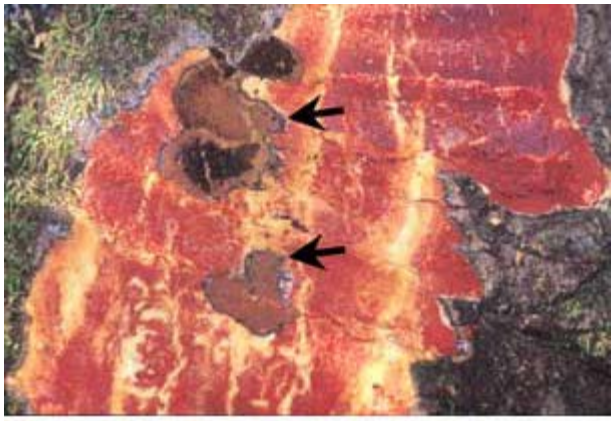
Necrotic bark tissues surrounded by black zone lines are usually present under affected bark. Because these symptoms can also be caused by other *Phytophthora* species, laboratory tests

must be done to confirm pathogen identity.

In the Eastern United States, other disorders of oaks have similar symptoms. See the reverse of this sheet for descriptions. If unusual oak mortality occurs and symptoms do not match these regional disorders, evaluate affected trees for *Phytophthora ramorum*.

In the United States, sudden oak death is known to occur only along the west coast. However, the fact that widely traded rhododendron ornamentals can be infected with the pathogen and the demonstrated susceptibility of some important eastern oaks make introduction to eastern hardwood forests a significant risk. Early detection will be important for successful eradication. Oaks defoliated early in the growing season by insects or pathogens may appear dead, but leaves usually reflush later in the season. Canker rots, slime flux, leaf scorch, root diseases, freeze damage, herbicide injury, and other ailments may cause symptoms similar to those caused by *P. ramorum*. Oak wilt, oak decline, and red oak borer damage are potentially the most confusing. See the reverse of this sheet for comparisons with sudden oak death symptoms.

Ooze bleeds from a canker on an infected oak.



Black zone lines are found under diseased bark in oak.

To report infected trees or to receive additional information, please contact your State or Federal forest health specialist. On the Internet, visit the SOD home page at www.suddenoakdeath.org. To distinguish this new disease from diseases with similar appearance, visit http://www.na.fs.fed.us/SOD.

Eastern Oak Disorders That Resemble Sudden Oak Death

In eastern hardwood forests, sudden oak death can be confused, in particular, with oak wilt, oak decline, and red oak borer damage. Descriptions of these disorders and comparisons with sudden oak death follow.

Oak Wilt

Oak wilt is an aggressive fungus disease caused by *Ceratocystis fagacearum*. It is one of the most serious diseases in the Eastern United States, killing thousands of oak trees in forests, woodlots, and home landscapes. Susceptible hosts include most oaks in the red oak group and Texas live oak. Symptoms

include wilting and discoloration of the foliage, premature leaf drop, and rapid death of the tree within days or weeks of the first symptoms. Trees become infected with oak wilt in two ways: through connections between root systems of adjacent trees, and through insects that carry the fungus to other trees that have been wounded.

Oak wilt quickly kills most infected trees. Wilting leaves turn brown at the margins (inset) and fall as the tree dies.

Similarities: Oak wilt can also kill trees very quickly, especially if infection begins through root grafts. Differences: The oak wilt pathogen does not cause cankers on the stems, and no bleeding is associated with this disease. Dark staining may be evident under the bark of trees with oak wilt, but there are no conspicuous zone lines. Oak wilt typically causes red oak leaves to turn brown around the edges while the veins remain green. Leaves are rapidly shed as the tree dies. Conversely, in live oak with the sudden oak death pathogen, the veins first turn yellow and eventually turn brown. Leaves are often retained on the tree after it dies.

Oak Decline

Oak decline is a slow-acting disease complex that can kill physiologically mature trees in the upper canopy. Decline results from interactions of multiple stresses, such as prolonged drought and spring defoliation by late frost or insects, opportunistic root disease fungi such as *Armillaria mellea*, and inner-bark-boring insects such as the twolined chestnut borer and red oak borer. Progressive dieback of the crown is the main symptom of oak decline and is an expression of an impaired root system. This disease can kill susceptible oaks within 3-5 years of the onset of crown symptoms. Oak decline occurs throughout the range of eastern hardwood forests, but is particularly common in the Southern Appalachian Mountains in North Carolina, Tennessee, and Virginia, as well as the Ozark Mountains in Arkansas and Missouri.

Similarities: Oak decline can cause death of

Oak decline can take years to kill an entire tree.

many oaks on a landscape scale. Moist, dark stains may be present on the trunk of trees affected by oak decline. Differences: Oak decline shows evidence that dieback has occurred over several years from the top down and outside inward. Newly killed branches with twigs attached are usually found in the same crown as those in a more advanced state of deterioration killed years before. Dieback associated with sudden oak death occurs over a growing season or two. The inner bark beneath the dark stain associated with stem-boring-insect attacks has a discrete margin with no zone lines or evidence of canker development beyond the attack site.

Red Oak Borer

Red oak borer (*Enaphalodes rufulus* (Haldeman)) attacks oaks of both red and white groups throughout the eastern United States, but prefers members of the red oak group; however, it does not kill trees. Outbreaks are associated with stressed trees that eventually die from oak decline. The complete life cycle takes 2 years. Adults are 1-1.5 inches long with antennae one to two times as long as the body. Larvae are the damaging life stage. Adult females lay eggs in mid-summer in refuges in the crevices of the bark. Newly hatched larvae bore into the phloem, where they mine an irregular burrow 0.5-1 inch in diameter before fall. In spring and summer of the second year, dark, moist stains and fine, granular frass may be seen on the trunk. Exposure of the inner bark reveals the

Tunnels in the inner bark indicate the presence of red oak borer.

frass-packed burrow and the larva, if it has not bored more deeply into the wood to complete development. Mature larvae are stout, round-headed grubs about 2 inches long before they pupate deep in the wood.

Similarities: Moist, dark stains and fi ne frass may be present at sites of red oak borer attack. Differences: With red oak borer the inner bark beneath the dark stain contains a frass-packed burrow and has a discrete margin with no zone lines or evidence of canker development beyond it.

For further information on related disorders:
Oak Wilt: src="/spfo/pubs/howtos/ht_oakwilt/toc.htm
Oak Decline: src="/spfo/pubs/fidls/oakdecline/oakdecline.htm
Red Oak Borer: src="/spfo/pubs/fidls/Red%20Oak%20Borer/redoak.htm
Other Pest Publications: src="/pubs

Prepared by:
Joseph G. O'Brien, USDA Forest Service, Northeastern Area
Manfred E. Mielke, USDA Forest Service, Northeastern Area
Steve Oak, USDA Forest Service, Southern Region
Bruce Moltzan, Missouri Dept. of Conservation